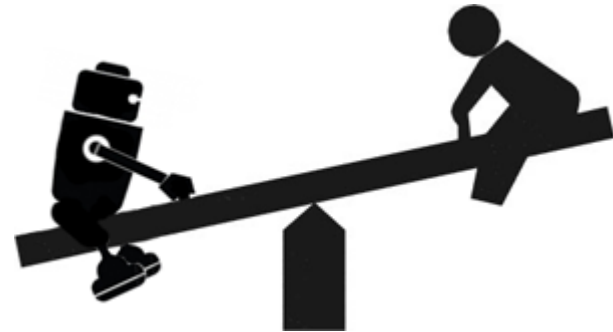


# **Policy learning using online reinforcement learning for an adaptive Liquid State Machine**

Purpose of the research:

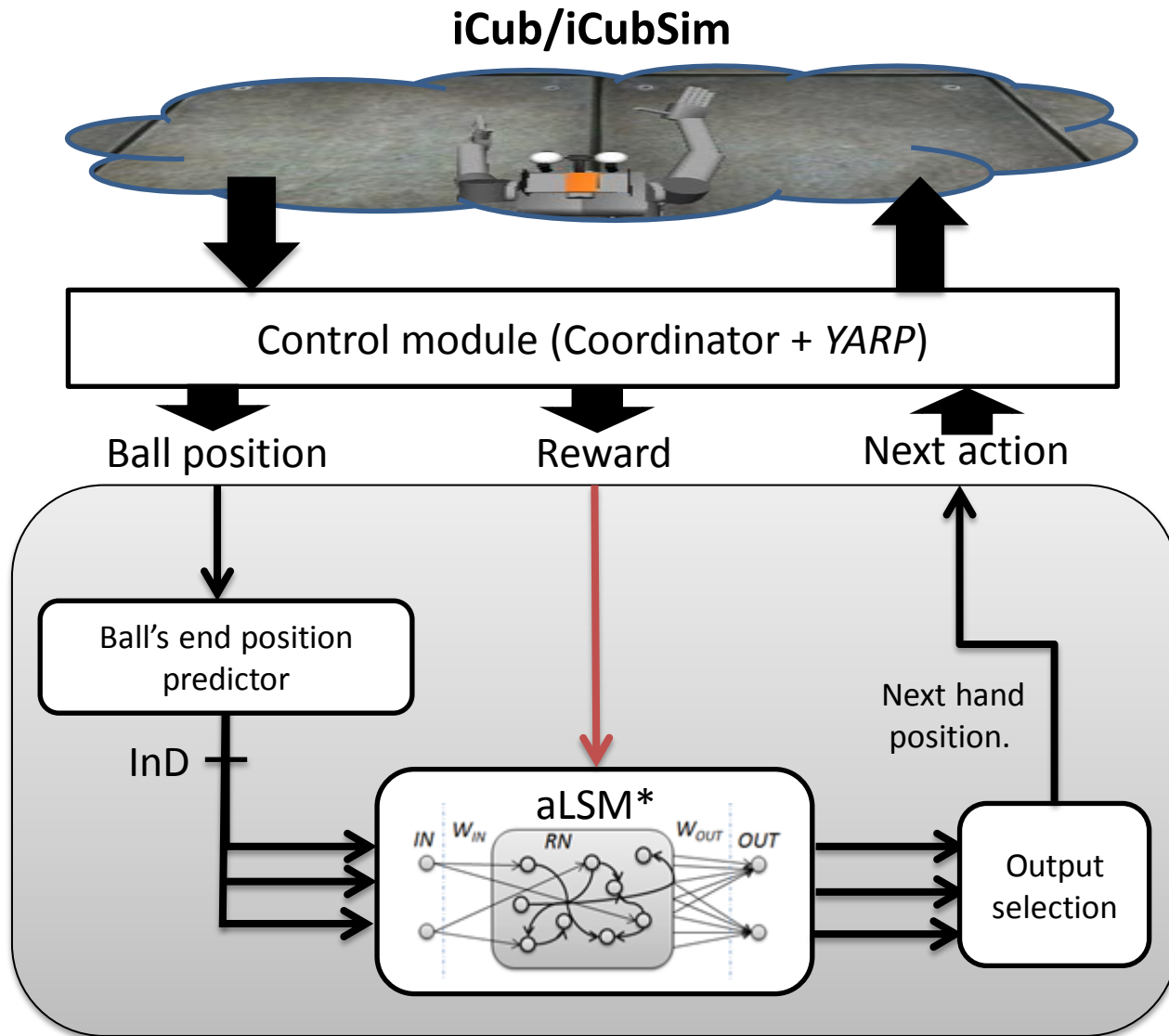
- Use human based network and learning to study how humans acquire cognitive functions. (for instance cooperation!)



Goal for the summer school:

- Implement an artificial spiking neuron network for policy learning.
- Collaborate with the EFAA group to teach iCub© the game of Pong©

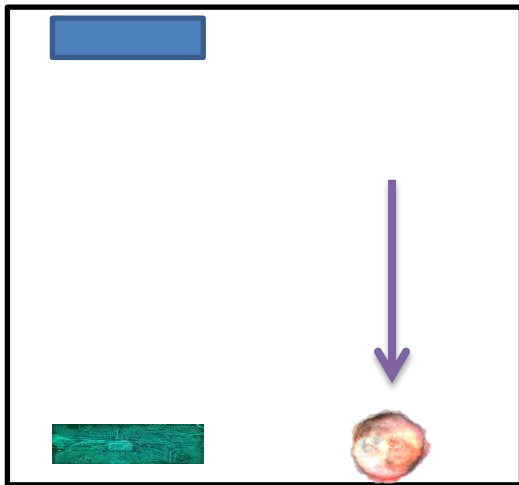
# Model for the learning



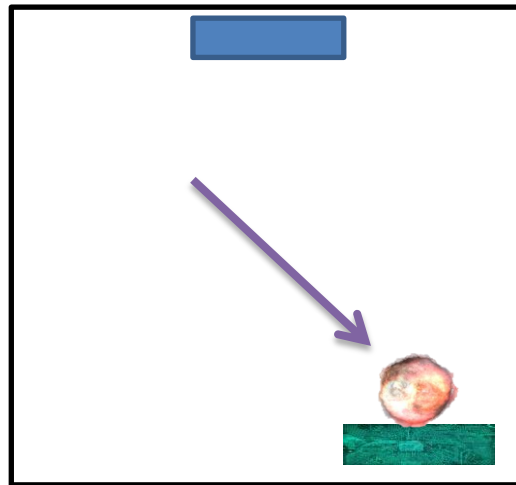
# Policy learning using online reinforcement learning for an adaptive Liquid State Machine

How pong can be learned?

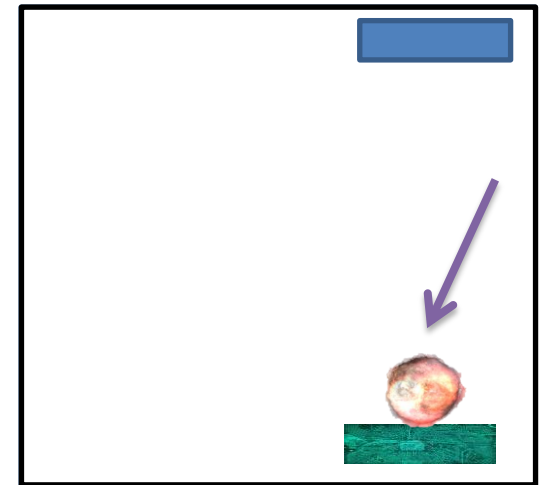
Using reinforcement learning!!



State: Missed ball!!!  
Reward: Negative.  
Learning speed: MAX!



State: Got ball!!!  
Reward: Positive.  
Learning speed: MAX!



State: Missed ball!!!  
Reward: Positive.  
Learning speed: MIN!

If the system gets positive reward, the same reaction for similar inputs is more likely to occur again. (*Thorn-like effect*)

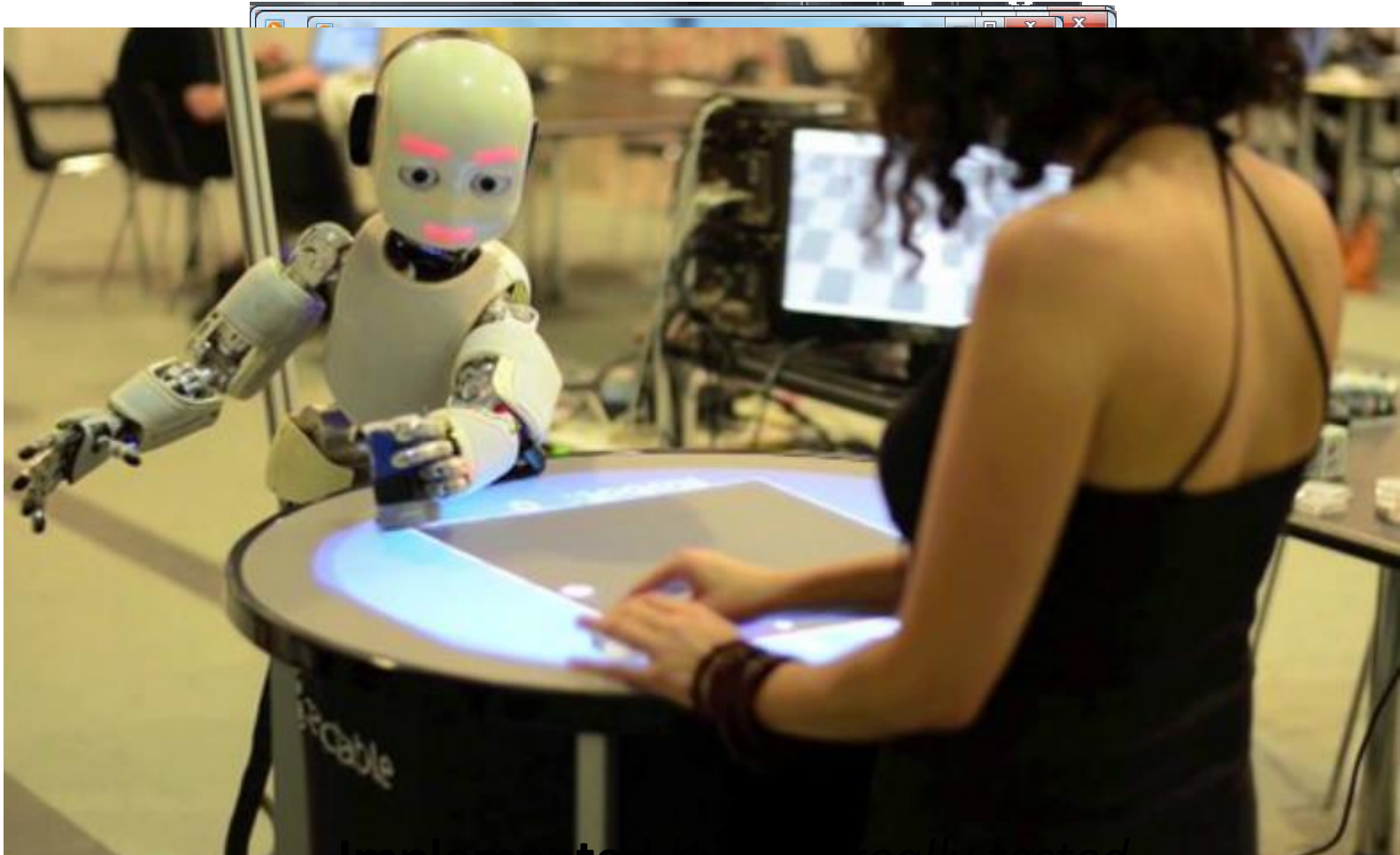
Else, if the system gets negative reward, the same reaction is less likely to be reproduced.

# Example

In Simulation

On iCub simulator

On iCub



Implemented *but not really tested*

# Conclusion

## Positive:

- The learning function is able to learn pong© without explicit rules.
- The learning is very fast and robust!
- Worked on simulation and relatively good on iCubSIM!

## Negative:

- We couldn't teach the real robot yet.
- The learning complexity is  $n^2$  → hardly scalable to big problems.

## Future work:

- The network should be improved to lower the complexity.
- Teach the real robot to play the game!

# Thank you!!

- *Especially to:*
  - *VVV13's organizers.*
  - *The EFAA team.*
  - *The IIT staff that took care of the iCub.*

